

The effectiveness of a training program based on information encoding strategies to improve word recognition skills in children with reading difficulties

فعالية برنامج تدريبي قائم على استراتيجيات ترميز المعلومات لتحسين مهارة التعرف على الكلمة لدى الأطفال ذوي صعوبات القراءة

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Abstract:

The study aimed to demonstrate the effectiveness of a training program based on cognitive strategies used during the encoding of sensory information to improve word recognition skills in children with reading difficulties. This was achieved by designing and proposing training activities according to the information processing theory, focusing on training the study sample on two cognitive strategies: the grouping strategy and the semantic scanning strategy, and training them to use and generalize these strategies in reading situations. Additionally, a set of tools was applied, including an intelligence test (Florence Goodenough's Draw-a-Man Test) as a standard tool for controlling the sample, and a reading test used in the core of the study designed to detect reading difficulties among fourth-grade students. The goal was to control the sample and evaluate their level of word recognition. The sample consisted of 30 fourth-grade students who did not have intelligence problems but all suffered from reading difficulties affecting word recognition skills. The research concluded that there was an

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improvement in reading recognition among the sample due to the effective role of the grouping strategy, without significant impact from the semantic scanning strategy.

Keywords: Word recognition; Reading difficulties; Cognitive strategies; Encoding; Information processing.

ملخص:

هدفت الدراسة إلى تبين فعالية برنامج تدريبي قائم على الإستراتيجيات المعرفية المستخدمة أثناء ترميز المعلومات الحسية، لتحسين مهارة التعرف على الكلمة عند الأطفال ذوي صعوبات القراءة، وذلك من خلال تصميم واقتراح أنشطة تدريبية وفق نظرية معالجة المعلومات تعتمد على تدريب أفراد عينة الدراسة على إستراتيجيتين معرفيتين هما إستراتيجية التجميع وإستراتيجية المسح الدلالي وتدريبهم على استعمالها وتعميمها في المواقف القرائية. كما قمنا بتطبيق مجموعة من الأدوات والمتمثلة في اختبار الذكاء (اختبار رسم الرجل) والذي يعد كأداة معيارية لضبط العينة، واختبار القراءة المستعمل في صميم الدراسة والمصمم قصد الكشف عن صعوبات القراءة عند تلاميذ الصف الرابع ابتدائي، هدفه هو ضبط العينة وكذا تقييم مستوى أفرادها في التعرف على الكلمة، تشكلت العينة من 30 تلميذ يدرسون في السنة الرابعة ابتدائي لا يعانون من مشاكل في الذكاء وكلهم يعانون من صعوبات في القراءة تمس مهارة التعرف على الكلمة. خلص البحث إلى تحسن التعرف القرائي عند العينة عبر الدور الفعال لإستراتيجية التجميع دون إستراتيجية المسح الدلالي. الكلمات المفتاحية: تعرف على كلمة؛ صعوبات قراءة؛ استراتيجيات معرفية؛ ترميز؛ معالجة معلومات.

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1. Problematic and Hypotheses

Word recognition skill is a crucial component of a good reader's toolkit at any level. A child who fails to develop effective methods for

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recognizing words appropriate to their level of progress will face significant linguistic challenges. This is because they will struggle with phonetic analysis of words, leading to difficulties in determining their meaning and understanding their relationship with other words within a linguistic context, whether spoken or written. Therefore, word recognition is a vital skill in written language as it serves as the gateway for students to make noticeable progress in reading proficiency, especially at the initial stages of learning. The process involves linking sensory stimuli related to words, whether auditory or visual, and the brain's ability to decode or interpret these words as symbols. Thus, possessing this skill signifies the true beginning of acquiring reading fluency skills (Abdul Bari, 2011, p. 199). Consequently, any difficulty in learning to read is inherently linked to challenges in encoding and decoding through various skills such as word recognition and its components (Perfetti, 1985). Cognitive strategies refer to the method of organizing information during processing to reduce its complexity and integrate it for proper use later (Conway, 2008, pp. 77-78). This cognitive approach is fundamental in explaining learning difficulties. Swanson & Rhine (1985) and Swanson & Cooney (1985) note that cognitive strategies learned and used by individuals with learning difficulties might be suitable for the required performance but are difficult for them to generalize to new tasks due to their failure to convert these strategies into more effective forms (Al-Zayat, 2007). Thus, effective use of these strategies is a source of differences between good and poor readers. They are conscious mental processes organized to facilitate an individual's performance on a specific task. Accordingly, weak readers are less proficient in active and planned strategies aimed at facilitating later recall (Kamhi & Catts, 1998, p. 77). Williamson & Nelson (2005) also point out that these students often use inefficient strategies inflexibly; hence training them on cognitive strategies will

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yield good results later (Ibrahim, 2011, p. 62). We have focused in our study on the encoding process as it is fundamental in word recognition skills. It forms the basis for storing information and mentally encoding it during various processing stages where it is encoded according to sensory medium or meaning or function (Al-Zayat, 2007). This process aims at translating information and storing it mentally; incorrectly encoded and stored information leads to incomplete or incorrect recall or forgetfulness, causing a general learning issue (Darwaza, 2004). Children with reading difficulties often suffer from deficiencies in encoding (Kamhi & Catts, 1998, p. 130). Some studies like Laberg & Samuel (1984) have concluded that reading difficulties are an imbalance disorder between encoding and reading processes (Al-Farmawi, 2011), indicating that poor readers have difficulties in encoding information and using strategies effectively for storage in working memory. These disorders affect reading skills level (Habib & Rey, 2000). These encoding strategies vary based on methods and mechanisms used for encoding and storing information for later retrieval. Strategies like grouping information involve clustering data units together due to shared characteristics for processing as a single group (Qatami, 2013, p. 511), thus reducing large incoming information by grouping it according to similar features with sensory attributes (auditory and visual) as a surface level of processing, as well as scanning and grouping those related to semantic properties at a deeper level of processing for easier retrieval later (Taouinat, 2009). Two specific strategies can be allocated for the encoding process: grouping strategy for auditory and visual coding of written symbols and scanning strategy for semantic coding. Based on all the above, our research will attempt training on appropriate cognitive strategies for encoding (the two selected strategies in the study) aimed at highlighting their role in improving word recognition skills among a group of fourth-grade

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Algerian school children who struggle with reading difficulties affecting this skill according to the test designed in the study to serve its objectives. This can only be achieved by placing these strategies within an organized methodological framework through implementing a proposed training program by the researcher containing activities for training on using these selected strategies based on theoretical heritage and previous studies on the subject. We will attempt to test their effectiveness on Algerian students by studying differences between pre-test and post-test results designed specifically for this purpose. The main research question we pose is:

- Are there statistically significant differences in word recognition test results between pre-test and post-test after training on encoding strategies?

This question branches into two sub-questions:

1. Are there statistically significant differences in word recognition test results between pre-test and post-test after training on the grouping strategy?
2. Are there statistically significant differences in word recognition test results between pre-test and post-test after training on semantic scanning strategy?

Hypothesis:

- There are statistically significant differences in the results of the word recognition test between the pre-test and post-test measurements after training on encoding strategies.

This main hypothesis branches into two sub-hypotheses, which are presented as follows:

1. There are statistically significant differences in the results of the word recognition test between the pre-test and post-test measurements after training on the grouping strategy.

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2. There are statistically significant differences in the results of the word recognition test between the pre-test and post-test measurements after training on the semantic scanning strategy.

2. Theoretical Framework:

2.1. Information Processing Theory:

Interest in the process of information processing as a cognitive process began in the 1940s, when cognitive psychologists sought to understand the mechanisms of these cognitive processes, including encoding, storage, and retrieval (Al-Atoom, 2004, p. 161). Atkinson and Shiffrin are considered pioneers in psychology who contributed to developing the theoretical framework for information processing, offering a perspective different from traditional cognitive theories. They focused on describing and explaining the cognitive processes occurring within humans and how these processes affect information processing (Al-Zaghloul, 2003). The information processing perspective represents a new and contemporary approach to understanding how information flows within the brain (Lerner, 2000). Butler (1998) also indicates that this perspective contributes to developing and preparing effective educational methods, programs, and techniques for teaching and treating individuals with academic and developmental learning difficulties, enabling them to become independent learners using cognitive and metacognitive strategies during the learning process (Al-Ayed, 2007, p. 6).

2.2. Encoding Process:

The encoding process, as one of the fundamental processes within the information processing system, is defined as the transformation that reformulates sensory-perceived information and environmental stimuli into mental representations that can be stored in memory. These processes require selective attention to information to ensure effective knowledge representation, as successful information

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processing cannot be completed without performing encoding and coding operations (Al-Atoom, 2004).

2.3. Types of Cognitive Processing Strategies in Reading Situations:

There are many types and different classifications of strategies used by learners depending on the required skill and activity. These strategies are classified either according to different memory systems (sensory memory, working memory, long-term memory) and are also called memory enhancement or recall strategies as mentioned in studies by Al-Ayed (2007), Taweinat (2009), and Al-Atoom (2004), or they are classified according to processes within these systems. These mainly include attention to sensory stimuli, encoding information, retrieving it, and recalling it (Al-Afoon & Jaleel, 2013, p. 24), as mentioned in the classification by Al-Saleeti (2008) and Al-Zayyat (2007), which we adopted in our current study.

2.4. Encoding Strategies:

These strategies rely on chunking, a method that helps reduce the number of cognitive units to match the storage capacity of short-term memory due to its limitations (Al-Atoom, 2004, p. 139). It aims to group information sharing certain elements into a single unit, allowing for new units to be received (Taweinat, 2009, p. 94). The cognitive strategies specific to the encoding process are determined by two basic types of strategies related to types of encoding: the first focuses on encoding and storing information based on its auditory and visual features, while the second focuses on its semantic properties (meaning encoding). In our study, we attempted to differentiate between these two strategies because they are based on the same principle—chunking—by choosing a specific name for each one (chunking/semantic scanning) based on what we relied on in training and also their similarity with other strategies.

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3. Field Study:

3.1. Study Methodology:

We adopted the experimental approach, where we developed a training program applied to the research sample. We used pre- and post-measurements to test reading difficulties, aiming to study the effect of the applied strategies in improving word recognition skills among fourth-grade elementary students with reading difficulties.

3.2. Study Sample:

The sample was purposefully selected by applying the tools used in the study. It consisted of 30 fourth-grade elementary students (both male and female), aged between 9-10 years, who suffer from reading difficulties affecting word recognition skills but possess normal intelligence. The study was conducted in the municipality of Raïs Hamidou, Algiers Province in the academic year 2016/2017.

3.3. Study Tools:

First: Reading Difficulties Test Designed by the Researchers:

1. Test Objective:

The test aims to identify the reading difficulties these students face in one of the fundamental skills of the reading process. This current study is part of a larger comprehensive study on reading skills (recognition and comprehension). Therefore, the designed test includes two sub-tests: one for word recognition skills and another for reading comprehension skills (Karboua and Nouani, 2019).

2. Sources Used in Test Construction:

This test was developed by adapting and selecting items from various sources and measures specific to reading and diagnosing its difficulties, including:

- Previous foreign and Arabic studies and research related to reading difficulties.
- Literature on reading, its difficulties, and measurement methods.

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- Theoretical foundations of word recognition, its difficulties, and measurement methods.
- Previous studies that divided written word recognition into its component sub-skills.
- Some tests and measures specific to reading skills, including:
 - Arabic Language Recognition Skills Test - Diagnostic Reading Test for Grades 1-3 (Al-Jarf, 1994).
 - Reading Comprehension Test (Ajaj, 1998).
 - Reading Comprehension Test for Second Preparatory Grade Students (Abdel Bari, 2009).
 - Dyslexia Diagnostic Test (Jaljal, 2015).
- Additionally, we borrowed some commonly used items from various foreign and Arabic tests like syllable comparison items in Odédys Test and Harris & Sipay's (1980) word recognition test.
- We also relied on other types of tests such as visual discrimination scale (Ridwan, 2004), auditory perception and discrimination tests, visual perception and discrimination tests, studies like Laboudi's (2005), and a range of sources on teaching reading activities with its skills and diagnosing its difficulties along with remedial training methods such as "Practical Guide for Teachers of Learning Difficulties" (Malkawi & Al-Khatib, 2012), as well as works by Barabah (2006), Gavin (2006), Jaljal (1995), Al-Zayat (2007), Asr (1992), Fahim (1999), Hillalan & Lloyd & Kaufman & Weiss (2007), Waqfi (2003), Tiereney et al., Dishner et al., Readence et al., Kathleen et al., Tom et al., Katina et al., Margret et al., Crawley & Merritt.
- Other references which cannot all be listed here were also used along with our previous studies on the subject and school textbooks.

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3. Measured Dimensions in the Test: The test measures:

- Auditory discrimination of written symbols.
- Visual discrimination of written symbols.
- Auditory-visual discrimination of written symbols.
- Word recognition as a unit.
- Phonetic recognition of words.
- Recognition of words from their structure.

4. Psychometric Properties of the Test:

4.1. Validity:

4.1.1. Expert Validity:

The following table illustrates experts' agreement percentages on each test item concerning these aspects.

Table (1) shows the approval percentages of the esteemed reviewers on the test items

Items	Evaluation Criteria		
	Formulation	Content	Age suitability
Auditory Discrimination	100%	80%	90%
visual discrimination	90%	80%	100%
audiovisual discrimination	100%	90%	90%
word recognition as a unit	100%	100%	100%
Speech Recognition of the Word	100%	100%	100%
Recognition of the Word from structure	90%	90%	90%

The approval rates for the phrasing, content, and age appropriateness indicate a significant acceptance by the reviewers of the test items. However, some reviewers pointed out the need for

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changes, particularly in images and vocabulary that they deemed not suitable for the child's educational level

4.1.2. Difficulty and Ease Index:

The test was conducted on a pilot sample. The collected results were analyzed and presented in the following table:

Table (2) illustrates the difficulty indice for the reading difficulties test

No	Item	Percentage
01	Auditory Discrimination	31%
02	visual discrimination	40%
03	audiovisual discrimination	40,5%
04	word recognition as a unit	60,5%
05	Speech Recognition of the Word	35%
06	Recognition of the Word from structure	56,5%
Total		43,91%

We observe from the table above that all the items are characterized by comprehension; they are neither very easy nor very difficult. This is because they have varied percentages ranging from 31% to 60.5%, which fall between the values of 30% and 70%. The desired difficulty index lies within these two values. Therefore, the test instructions and questions are characterized by a moderate level of ease and difficulty for the pilot study sample.

4.1.3. Discrimination Index:

The following explains the results of the discrimination indices for all test items:

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Table (3) illustrates the discrimination index for the items of the reading difficulties test

No	Item	Discriminatory Coefficient
01	Auditory Discrimination	0,47
02	visual discrimination	0,50
03	audiovisual discrimination	0,49
04	word recognition as a unit	0,77
05	Speech Recognition of the Word	0,63
06	Recognition of the Word from structure	0,57
Total		0,67

From Table 3, we observe that the lowest value is (0.47) and the highest value is (0.77). The overall discrimination index for the test is (0.67), which falls within the acceptable range. This indicates the strong ability of all test items to differentiate between weaker and stronger students.

4.1.4. Internal Consistency:

This measures the homogeneity among the test items. The results are illustrated in the following table:

Table (4) shows the internal consistency reliability of the test items

No	Item	Correlation Coefficient	Level of Significance
1	Auditory Discrimination	86,0	000,0
2	visual discrimination	91,0	000,0
3	audiovisual discrimination	92,0	0.000
4	word recognition as a unit	95,0	000,0
5	Speech Recognition of the Word	95,0	000,0
6	Recognition of the Word from structure	92,0	000,0

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We observe from Table No. (4) that the Pearson correlation coefficients between the results of each item and the overall test results ranged from (0.86) to (0.95), which are significant at the 0.01 level of significance. This indicates that the test has a strong indicator for measuring what it was designed to measure, providing us with greater validity and reliability in the results.

4.2. Reliability:

The researcher calculated reliability through the method of test-retest on the same pilot sample, with a time interval of 18 days. The following table illustrates this:

Table (5) shows the reliability coefficient of the test

Level of Significance	Reliability Coefficient
000,0	66,0

We observe from Table No. (5) that the total reliability of the reading difficulties test using Pearson's correlation coefficient reached (0.66), which is significant at the (0.01) level. This result confirms that the test has strong reliability over time, which in turn confirms the accuracy of the results obtained in the main study.

Secondly: Florence Goodenough's Draw-a-Man Test

We applied this test to the study sample to determine its composition. Two cases were excluded as they scored less than 85 on the applied intelligence test.

Thirdly: Description of the Proposed Training Program

To improve word recognition skills, we attempted to address encoding as a cognitive process or a stage in processing according to cognitive theory models for interpreting learning and acquisition processes and their challenges. We aimed to present a set of training activities designed to enhance encoding abilities in its various forms (auditory/visual/semantic), following the strategies of chunking and

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semantic mapping. These activities are designed based on theoretical foundations of information processing and inspired by previous studies addressing reading difficulties. The following table summarizes the cognitive strategies used in the program, their objectives, and training methods:

Table (6) illustrates the strategies and the training procedures for them

Cognitive Strategies	Objective	Training Activities
Grouping Strategy	Developing the ability for audio-visual encoding and storage (sound/form)	Training in Encoding Visual Features . Training in Encoding Auditory Features. Training in Encoding Audiovisual Features.
Semantic Scanning Strategy	Developing the ability to encode meaning	Training on Semantic Word Scanning. Training on Semantic Sentence Scanning.

Program Validation:

The program was presented to a panel of five university professors specializing in psychology, speech therapy, and educational sciences. This was done to assess the appropriateness of the program's components and the cognitive strategies applied, as well as the suitability of its objectives. Additionally, the clarity of the training activity instructions and the tools, and how well they represent the cognitive strategies being addressed were evaluated, as detailed below:

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Table (7) shows the percentages of evaluators' agreement on the aspects of evaluating the training program

Aspects of Arbitration/Strategies	Relevance of strategies	Relevance of training methods	Relevance of objectives	Relevance of activities and resources
First Strategy	100%	90%	100%	70%
Second Strategy	80%	80%	90%	80%
Program	90%	85%	95%	75%

From Table No. (7), we observe that the agreement rate on the appropriateness of the strategies is 90%, the appropriateness of the training methods is 85%, the appropriateness of the objectives is 95%, and the appropriateness of the training activities and means used is 75%. These percentages represent a high degree of agreement among the judges on most of the program content and evaluated aspects. The remarks of the judges were taken into consideration, and we made the necessary and required adjustments, resulting in the formulation of the final training program.

4. Presentation and Discussion of Results:

4.1. Presentation and Discussion of Results According to the Main Hypothesis:

The main hypothesis states that "there are statistically significant differences in the results of the word recognition test between pre- and post-measurements in favor of the post-measurement after training on encoding strategies." The following table illustrates its statistical results.

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Table (8) illustrates the results of the T-test between the pre-test and post-test measurements on encoding strategies

T-test Results/ Training Program	Measurements	Mean	Standard Deviation	Difference of Means	T	ddl	Sig . Bilatéral
Encoding Strategies	Pre-test	70,15	26,3	-66,2	-78,9	29	000,0
	Post- test	36,18	60,3				

Statistical significance at $\alpha = 0.05$ (N=30)

The table (8) indicates that the value of $t=-9.78$ at a two-tailed significance level of 0.00 which is less than 0.05. This means that the differences in the results are statistically significant at the significance level $\alpha=0.05$. The negative sign of the "t" value indicates that these differences favor the post-test measurement. This result confirms the main hypothesis of the study. This outcome underscores the ability to acquire and employ strategies that aid in encoding and storing information correctly in memory during reading, and their role in improving word recognition skills among these children and in reading in general. The encoding process can be linked to sound (auditory symbol), shape (visual symbol), or meaning (semantic symbol), which was the focus during reading training. The results of this hypothesis are supported by previous studies, such as the study by Laberg & Samuel (1984), which indicated that reading difficulties are a disorder in the balance between encoding and reading processes (Al-Farmawi, 2011). Additionally, theoretical literature suggests that poor readers have difficulties in encoding information (Habib & Rey, 2000) and often suffer from encoding deficits (Kamhi & Catts, 1998, p.130). Therefore,

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the results of the main hypothesis are consistent with previous studies on one hand and with theoretical literature on the other hand, which shows that difficulties in word recognition arise due to failure in deriving and using appropriate strategies for storing and encoding information.

4.2 Presentation and Discussion of Results According to the First Sub-Hypothesis:

The following was included: "There are statistically significant differences in the results of the word recognition test between pre-test and post-test measurements, favoring the post-test, after training on the grouping strategy." The table below shows its statistical results:

Table (9) shows the results of the T-test between the pre-test and post-test measurements on the aggregation strategy

T-test Results/ Training Program	Measurements	Mean	Standard Deviation	Difference of Means	T	Ddl	Sig . Bilatéral
Grouping Strategy	Pre-test	70,15	26,3	-83,2	-27,10	29	0.000
	Post- test	53,18	56,3				

Statistical significance at $\alpha = 0.05$ (N=30)

Based on Table (9), we observe that the value of $t=-10.27$ at a two-tailed significance level of 0.00, which is less than 0.05 This indicates that the differences in the results are statistically significant at the significance level $\alpha=0.05$. The negative value suggests that these differences favor the post-test measurement, confirming the validity of the first partial hypothesis. This result emphasizes that aggregation as a cognitive processing strategy plays a role in improving word recognition skills among students who struggle with them. We consider

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this result logical, as the training focused on how to properly store the visual image of a letter—its written symbol—and the auditory encoding of its sound, then linking and encoding these auditory and visual characteristics together in memory in their correct form. Encoding fundamentally relies on distinguishing the characteristics of the information to be stored from other information. This strategy depends on grouping and linking information with similar elements into a single unit to make room for new units to enter. This result aligns with theoretical literature, which states that individuals encode and store information according to strategies based on associative relationships through correlated grouping of learned material.

4.3 Presentation and Analysis of Statistical Results According to the Second Partial Hypothesis:

This hypothesis states: "There are statistically significant differences in the results of the word recognition test between pre-test and post-test measurements, favoring the post-test, after training on the semantic scanning strategy." The statistical results for this hypothesis are shown in the following table:

Table (10) illustrates the results of the comparison between the pre-test and post-test measurements on the semantic survey strategy

T-test Results/ Training Program	Measurements	Mean	Standard Deviation	Difference of Means	T	Ddl	Sig . Bilatéral
Semantic Scanning Strategy	Pre- test	53,18	56,3	16,0	54,1	29	0.13
	Post- test	36,18	60,3				

Statistical significance at ($\alpha=0.05$) (N=30)

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We observe that the value ($t = 1.54$) at a two-tailed significance level (0.13) is greater than (0.05), indicating that there are no statistically significant differences in the results at the significance level ($\alpha=0.05$). This refutes the validity of the second partial hypothesis. The result confirms that the semantic mapping strategy, which we attempted to impart to students and train them on for proper encoding of information during reading, was not effective in improving their word recognition skills. We interpret this as the strategy focusing more on the concept and how it is stored by linking it to previous experience. It primarily aims to develop the ability to encode meanings and connotations, which contributes more to reading comprehension skills rather than word recognition skills, despite their connection.

Conclusion :

Finally we can say that using cognitive processing strategies with individuals with reading difficulties and training them on these strategies increases their ability to understand and learn essential cognitive processes for reading. This training provides them with guidance on representing and accurately perceiving the reading situation, relying on stored information in memory and activating it, thereby building organized steps to achieve the goal of reading, which is correctly recognizing written symbols. These strategies teach them how to functionally process information within various memory systems and components. They are characterized by functional integration and overlap and contribute to improving reading performance if trained on using and deriving appropriate strategies for these children's required performance.

Recommendations and Suggestions:

- Utilize cognitive strategies generally in teaching reading to students and in treating those who exhibit difficulties in it.

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- Train teachers as well as specialists in speech therapy, psychology, and educational sciences working in the field of reading difficulties to raise their awareness of the importance of cognitive processing strategies in improving reading skills and benefiting from information processing theory.
- The researchers also suggest conducting new studies that address different educational stages, as well as cognitive processes and other strategies that were not covered in our research.

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